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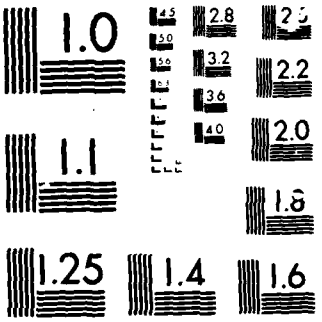

MICROCOPY CHART

AFGL-TR-85-0236

DESIGN, FABRICATE AND TEST SPACECRAFT AUTOMATIC ACTIVE DISCHARGE SYSTEM (SAADS)

Robert S. Hills

TRI-CON ASSOCIATES, INC.
765 Concord Avenue
Cambridge, Massachusetts 02138

Date of Report: September 25, 1985

Final Report: Period Covered
20 July 1983 to 15 June 1985

Approved for Public Release; Distribution Unlimited

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFB, MASSACHUSETTS 01731

"This technical report has been reviewed and is approved for publication."

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MICROPROCESSOR PROGRAMMER
PROTON ELECTROSTATIC ANALYZER
PLASMA SOURCE

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

A system designed to dissipate charge on a spacecraft by detecting the charge with a Proton Electrostatic Analyzer and activating a Plasma Source which short circuits the charge.

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LIST OF FIGURES

1.0 OBJECTIVE OF CONTRACT

The objective of this contract is the design, fabrication, and testing of a Spacecraft Automatic Active Discharge System (SAADS). The system will attempt to automatically control the vehicle charge as a function of natural or induced disturbances in space.

A microprocessor based controller will monitor and manipulate data from a Proton Electrostatic Analyzer (ESA) to determine if the vehicle charge is greater than a predetermined value and then activate a Plasma Source to discharge the vehicle.

2.0 INTRODUCTION

This equipment is to be flown as part of the BERT I Payload to demonstrate the feasibility of the system for eventual use in a satellite in a true space environment. It consists of a Proton Electrostatic Analyzer (ESA) (made by IRT Corporation and available to TRI-CON as Government Furnished Equipment) (GFE) and a Plasma Source made by Jet Propulsion Laboratory also supplied as GFE, plus a microprocessor based controller which is to be built by TRI-CON ASSOCIATES, INC.

3.0 CONFIGURATION

The High Resolution ESA is included in the SAADS package since it, like the IRT ESA, requires prelaunch pump-out and a blow-off door. Wentworth Institute did the design and fabrication of the extenstion can. The upper section has both ESA units located behind a common blow-off door. The large center section contains the JPL Plasma Source. The TRI-CON programmer box is same size as the BERT I programmer box and is on the bottom plate.

4.0 IRT ELECTROSTATIC ANALYZER MODIFICATIONS

The instrument used to detect vehicle to plasma potential is an electrostatic analyzer designed and fabricated by IRT Corporation in San Diego, California. The instrument was supplied as an eight channel device covering the range of 50 to 20,000 volts with the full width half maximum of each channel as shown in Figure 1.

During tests at AFGL the low energy channels were observed to drift with temperature to such a degree that a redesign of the plate high voltage bias circuits was necessary.

The cause of the drift was attributed to the way in which the bias voltage was derived. The IRT method for generating the bias voltage is to subtract one high voltage from another.

The problem arises when the difference voltage is in the order of 10 volts. The reference high voltage supply which is also the channeltron bias is normally set between 2500 and 3000 volts.

A 0.1% drift in the high voltage would result in a 30% drift in the resulting bias.

To improve the temperature stability, a linear high voltage feedback amplifier was designed and is shown schematically in Figure 2. The energy level for each channel was reduced to simplify the amplifier design and increase the reliability.

The maximum particle beam energy to produce vehicle charging on the BERT I payload is 4500 volts which is less than 1/4 of the original IRT range. The new design has eight channels to cover 50 volts to 10,000 volts. The new high voltage bias design has a much faster response time which results in a shorter scan and better altitude resolution.

A reprogramming of the UV erasable proms was required to generate the new incremental voltages and to minimize the dwell time between steps.

5.0 PROGRAMMER

The programmer uses the same box design as the BERT I Programmer Box. A decision to use the 6809 microprocessor means that the program card is a duplicate of the BERT I card. The memory card has been updated to give more memory by using higher density RAM chips.

The SAADS Flight Monitor Program was developed using the Zenith Z-100 microcomputer as the host computer, supplying the necessary editing, code assembly, and program downloading.

The text editor (VEDIT by Compuview) and cross assembler (XASM6809 by 2500 A.D. software) are generic packages and run on any microcomputer capable of running MS-DOS (Microsoft Disk Operating System). Downloading of developed programs into the SAADS programmer was accomplished with a terminal emulator program (PC/Intercomm by Mark of the Unicorn Software). This program is hardware dependent and will run only on a

Zenith Z-100 microcomputer.

Downloading programs into the SAADS programmer was done through the use of a monitor PROM (HUMBUG-09 by Starkits) with program debugging capabilities.

An algorithm to determine the vehicle charge from the IRT data was developed by Bedford Research Associates (BRA) on a separate contract. However, it was not used. Another algorithm was developed and is now burned into the flight PROM, along with the instrument program.

Using the above software, basics of the SAADS Flight Monitor were written. This include codes to:

(1) Read data from IRT's ESA
(2) Read the A/D converter
(3) Read a command from the BERT Programmer
(4) Write a command to the JPL Plasma Source
(5) Write data into the TM Shift Registers.

A Block Diagram of the SAADS is given in Figure 3.

The memory map of data storage on the memory board of the programmer is given below.

0000	Data for Flight
0090	IRT Data and SIOS
0100	Data for D-R06
4000	D-R06 Monitor (2K)
D000	Flight Monitor
D200	SIOS
F000	Humbug

A schematic of the Programmer Input/Output board is given in Figure 4.

5.1 Telemetry Format

The telemetry format is given in Figure 5.

6.0 SAADS UNITS TESTED

The SAADS units were tested at AFGL. The programmer received data from the IRT Analyzer, processed it using the algorithm and was to control the JPL plasma source. However the plasma source was not available for the flight. The IRT data was put onto telemetry.

7.0 FIELD TRIP

The system was assembled as part of the BERT I Payload and shipped to White Sands Missile Range. Charles Risicato of TC assisted at the launch which took place the night of June 14, 1985.

Unfortunately, the telemetry encoder malfunctioned when the electron gun of the BERT system was energized and no good data was received.

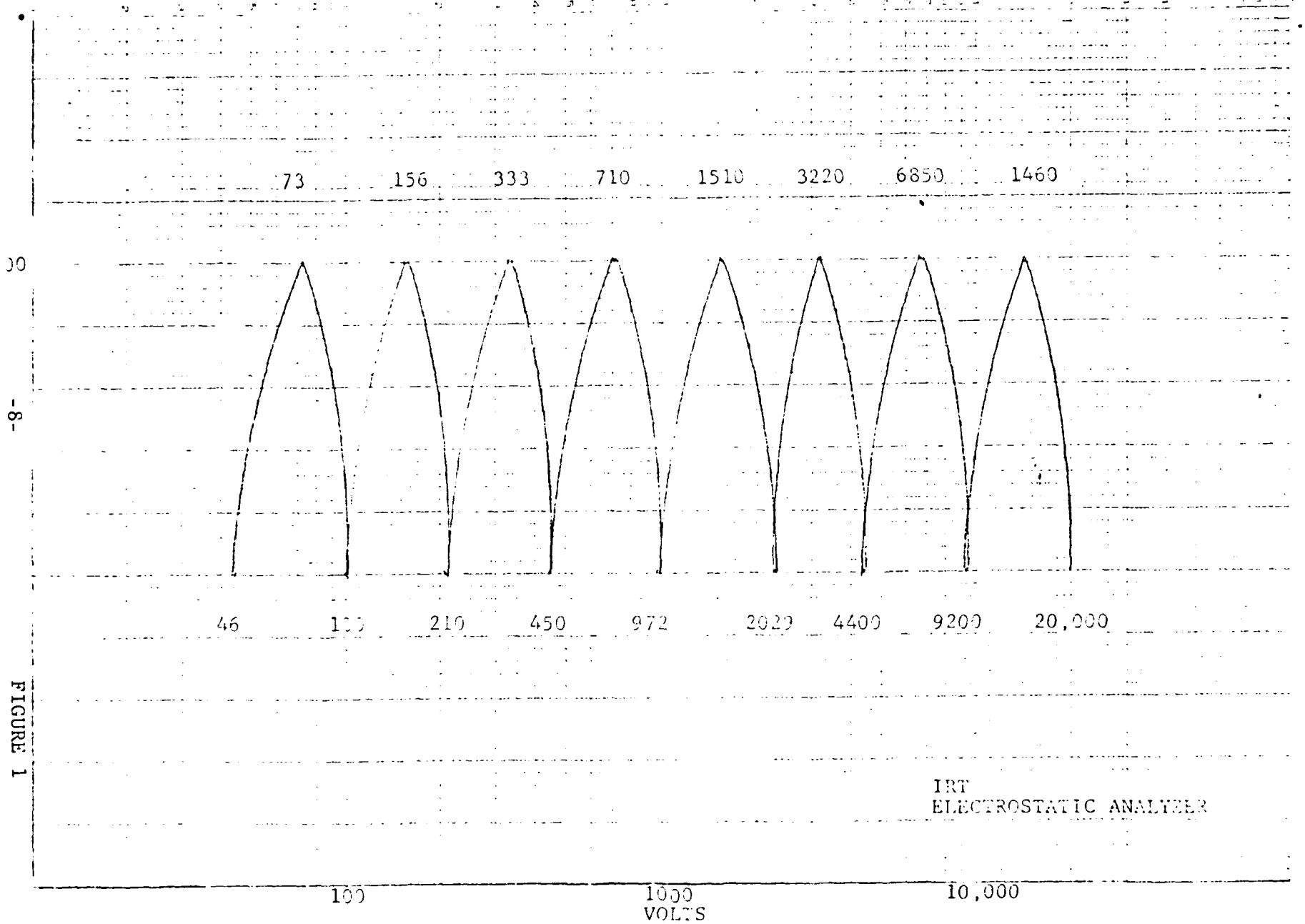
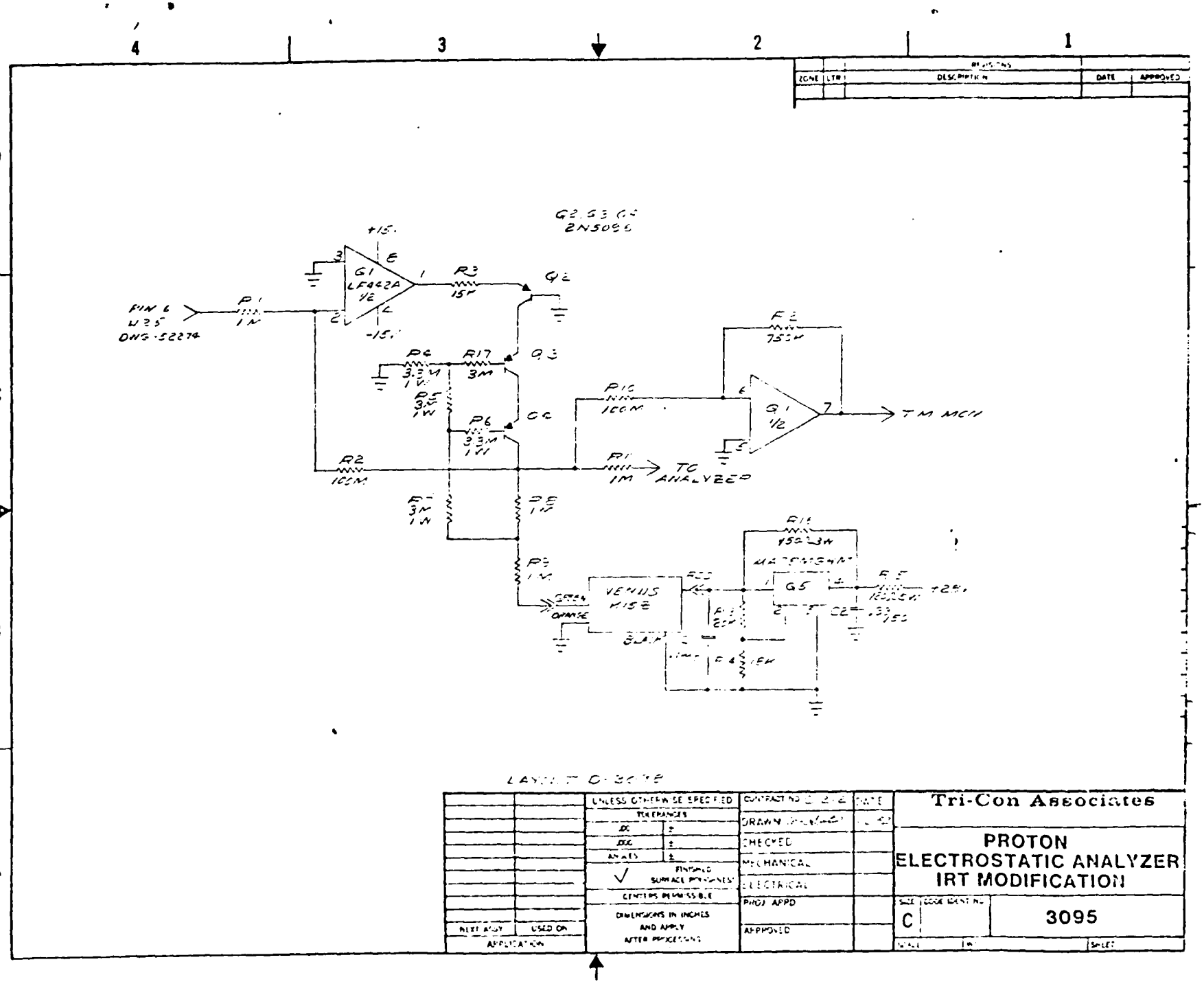

73
156
333
710
1510
3220
6850
1460
46
100
210
450
972
2020
4400
9200
20,000
IRT
ELECTROSTATIC ANALYZER
100
1000
VOLTS
10,000

FIGURE 1



LAYOUT DRAWING

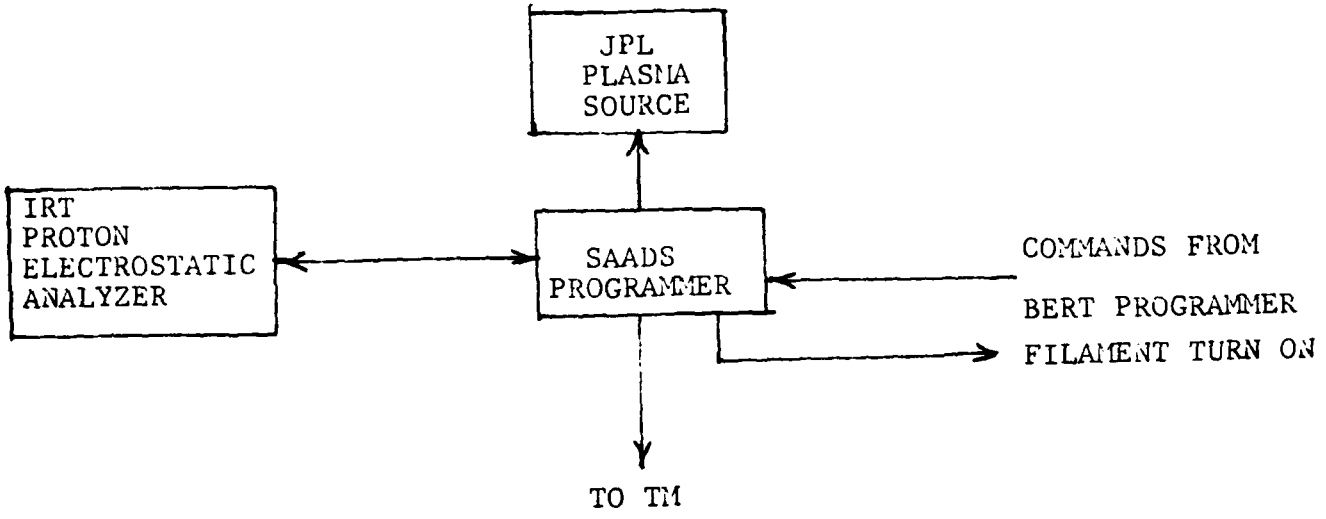
UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	DATE
TOLERANCES	DRAWN	
.XX ±	CHECKED	
.XXX ±	MECHANICAL	
ANGLES ±	ELECTRICAL	
✓ FINISH SURFACE ROUGHNESS	PROJ APPD	
CENTERS PERMISSIBLE	APPROVED	
DIMENSIONS IN INCHES AND APPLY AFTER PROCESSING		
NEXT ASSY / USED ON APPLICATION		

Tri-Con Associates

PROTON
ELECTROSTATIC ANALYZER
IRT MODIFICATION

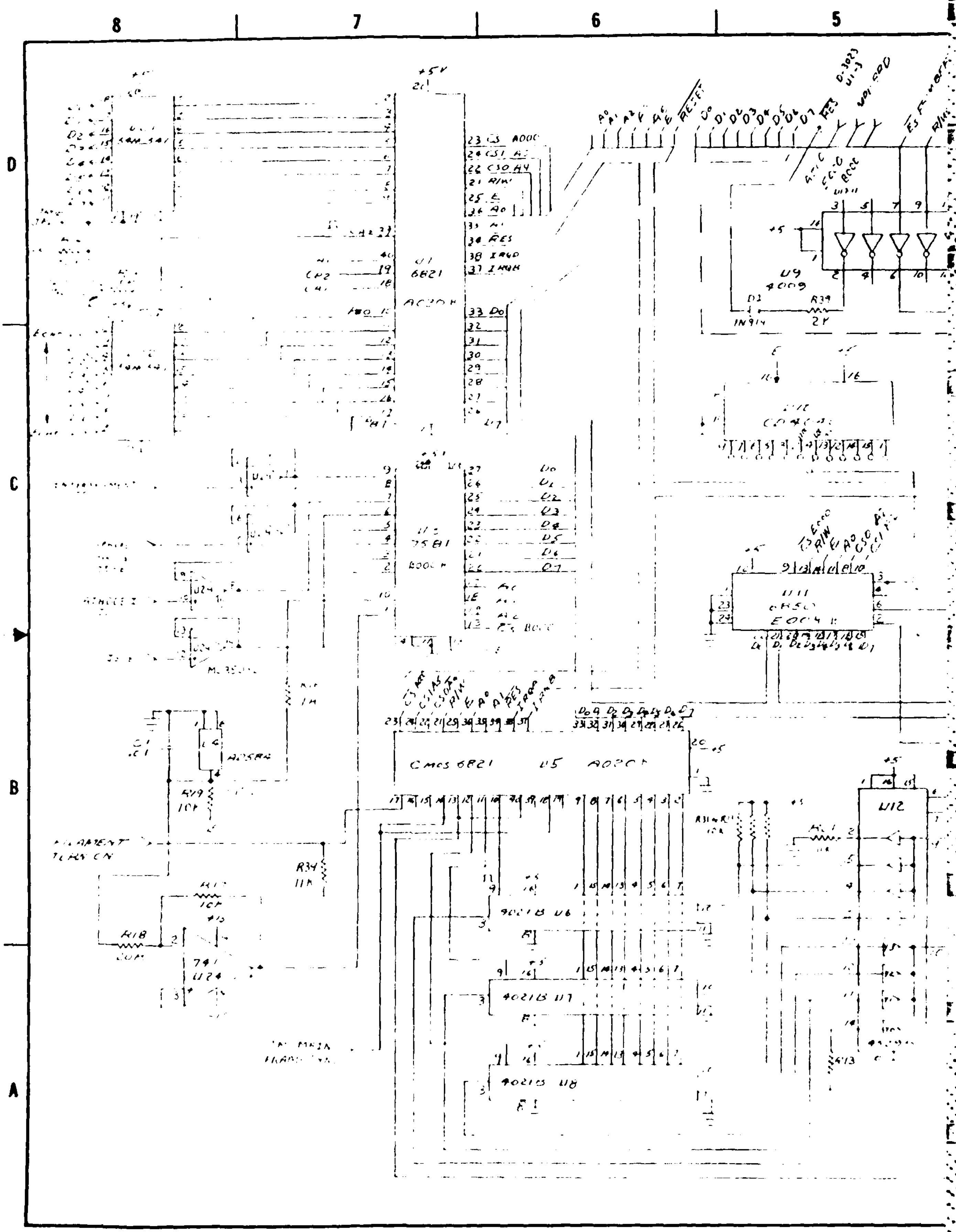
SIZE	CODE IDENT NO.	
C		3095
SCALE		SHEET

FIGURE 2

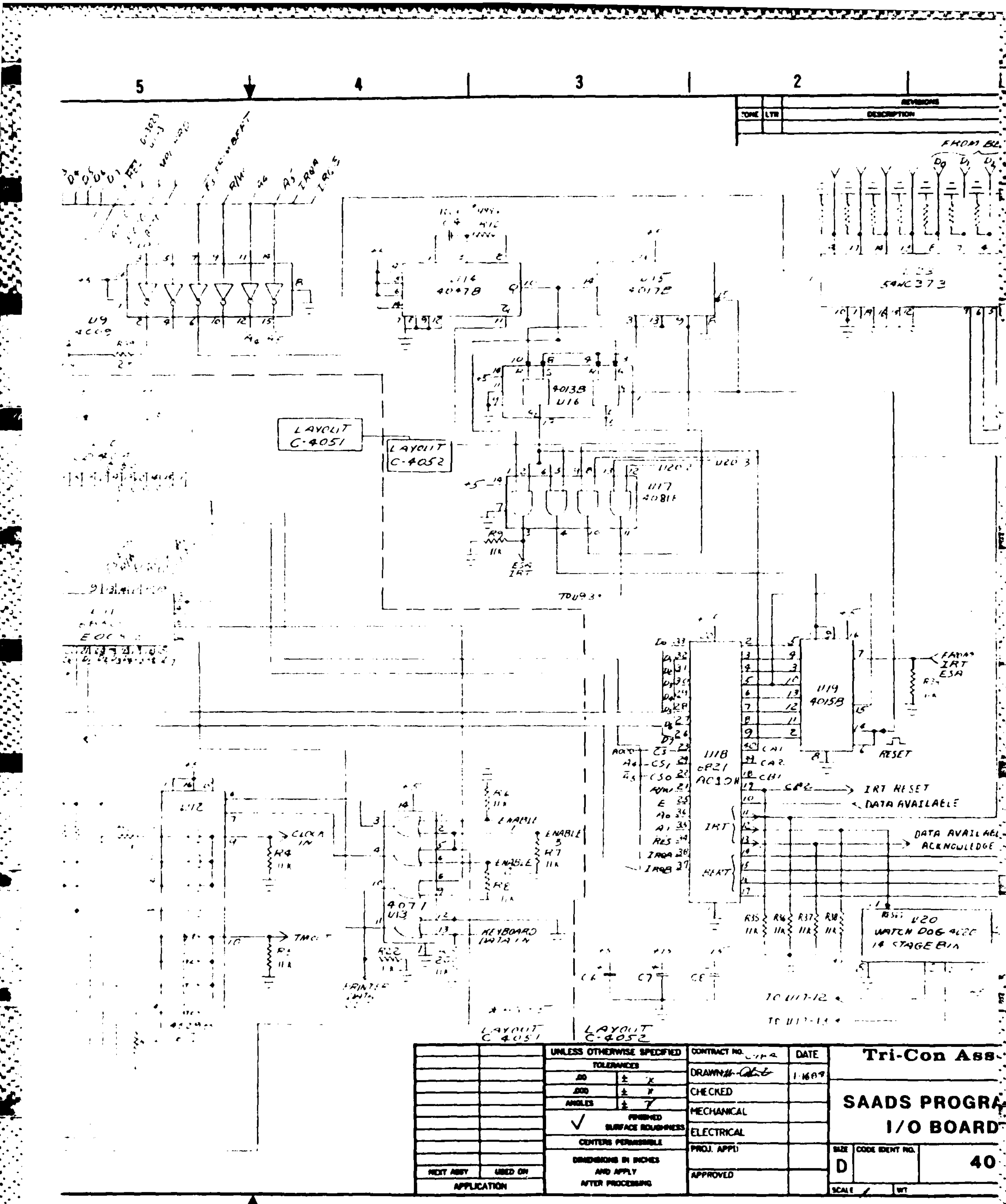


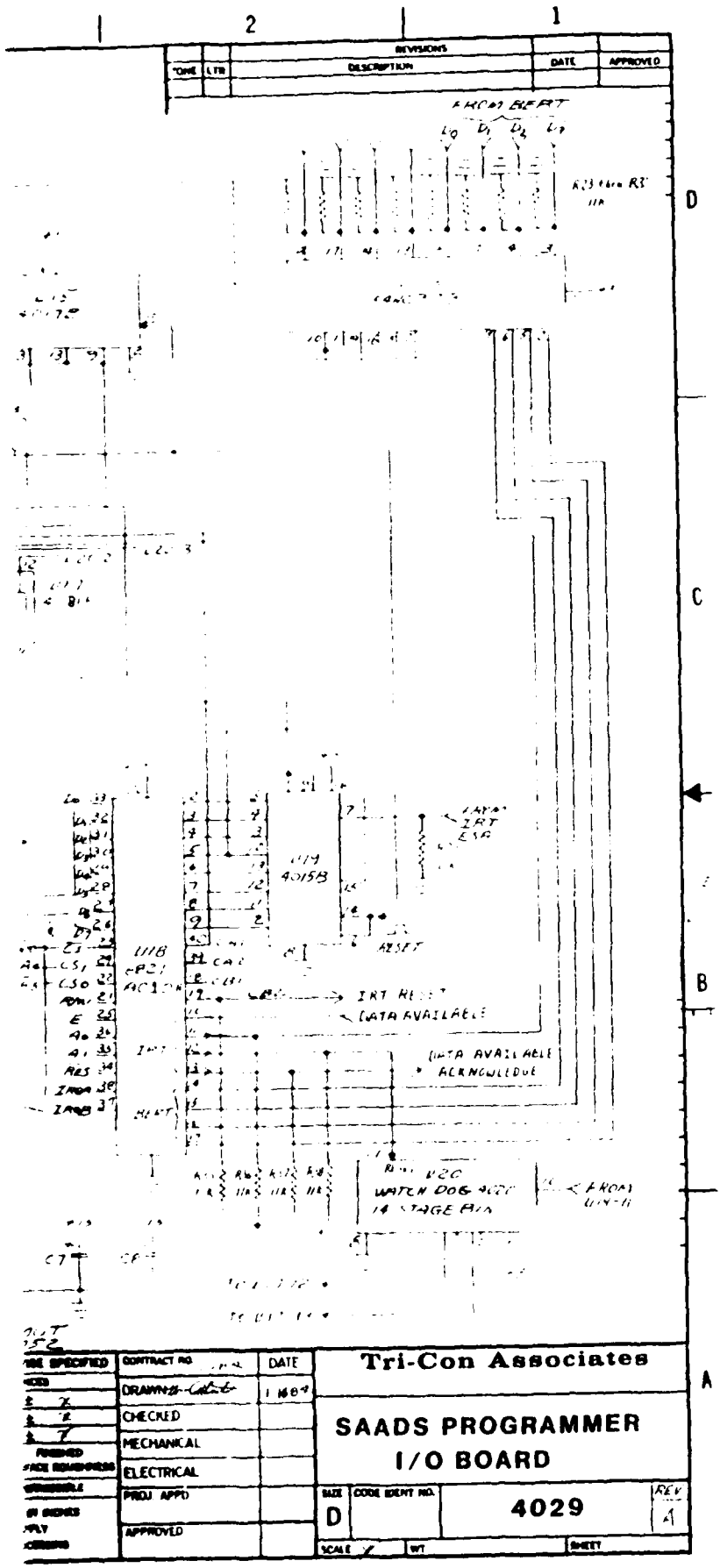
BLOCK DIAGRAM

FIGURE 3



8
7
6
5
D
C
B
A
+5V
6821
U1
Cmos 6821
U5
4021B U6
4021B U7
4021B U8
U9
4009
U11
U12
IN914
R39
R18
R19
R34
11K
741
U24
FILAMENT TURN ON


REVISIONS
DESCRIPTION
FROM BL
54HC373
4047B
4017B
4013B
U16
LAYOUT C-4051
LAYOUT C-4052
U17
4081F
U19
4015B
U18
6P21
IRT RESET
DATA AVAILABLE
DATA AVAILABLE ACKNOWLEDGE
RESET
U20
WATCH DOG 4020
14 STAGE B/N
U13
4071
KEYBOARD DATA IN
CLOCK IN
ENABLE
PRINTER DATA
UNLESS OTHERWISE SPECIFIED
TOLERANCES
ANGLES
FINISHED SURFACE ROUGHNESS
CENTERS PERMISSIBLE
DIMENSIONS IN INCHES AND APPLY AFTER PROCESSING
NEXT ASSY
USED ON
APPLICATION
CONTRACT NO.
DATE
DRAWN
CHECKED
MECHANICAL
ELECTRICAL
PROJ. APPD
APPROVED
Tri-Con Ass
SAADS PROGRA
I/O BOARD
SIZE
D
CODE IDENT NO.
40
SCALE
WT


2
1
REVISIONS
ZONE
LTR
DESCRIPTION
DATE
APPROVED
D
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A
IRT RESET
DATA AVAILABLE
DATA AVAILABLE
ACKNOWLEDGE
WATCH DOG
14 STAGE
CONTRACT NO.
DRAWN
CHECKED
MECHANICAL
ELECTRICAL
PROJ APPD
APPROVED
DATE
Tri-Con Associates
SAADS PROGRAMMER
I/O BOARD
SIZE
D
CODE IDENT NO.
4029
REV
A
SCALE
WT
SHEET

FIGURE 4

3

FRAME	WORD 17	WORD 18	WORD 19
1	MSB	LSB	CHANNEL 1 IDENT 50
2	"	"	CHANNEL 2 51
3	"	"	CHANNEL 3 52
4	"	"	CHANNEL 4 53
5	"	"	CHANNEL 5 54
6	"	"	CHANNEL 6 55
7	"	"	CHANNEL 7 56
8	"	"	CHANNEL 8 57
9	CHANNEL # WITH MOST COUNTS	COMMAND FROM BERT	ALL 1's FIL ON " 0's FIL OFF
10	ISV OUTPUT	SPHERE OUTPUT ZERO AT 3.75	JPL CATHODE I

TELEMETRY FORMAT

FIGURE 5

END

FILMED

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DTIC